Report for 2001WY1781B: Erosion Potential Model Development and Channel Monitoring

- Dissertations:
  - Baxter, Jeffrey, 2002, The Channel Geometry Of Dead Horse Creek, Powder River Basin, Wyoming, MS Dissertation, Department of Geography and Recreation, University of Wyoming, Laramie, WY, pp. 88.

Report Follows:

Problem and Research Objectives:

Coal bed methane (CBM) development in the Powder River (structural) Basin (PRB), located in northeast Wyoming, has been occurring at an increasing rate since about 1990 (WOGCC, 2000). As of March 2001 about 4,900 coalbed methane gas wells were in production, about 9,600 wells have been drilled and 600 of those have been plugged, and about 10 wells are drilled every day of the week (Bleizeffer, 2001).

The process of extracting coal bed methane involves drilling a well into a coal seam and then pumping water out of the well that is mixed with the methane in the coal seam. The gas and water separate in the well and the gas is sent to a pipeline. On average, water from CBM wells is produced at a rate of 12 gpm per well (BLM, 1999).

In June 2000 the U.S. Bureau of Land Management (BLM) held public scooping meetings to facilitate development of a new resource management plan for oil and gas development in all of Johnson, Campbell, and Sheridan counties as well as a significant portion of Converse County (Figure 1; Tollefson, 2001). At that time the BLM was looking at analyzing the impacts of having up to 35,000 wells developed in a 10-year period (although as many as 70,000 wells may be constructed over the lifetime of the development). Assuming that 33% of the 35,000 anticipated CBM wells are producing 12 gpm of water at a given time, surface water would be produced at an average rate of 140,000 gpm (312 cfs or 225,000 ac-ft/yr). For comparison, note that the storage capacities of Keyhole Reservoir and Lake de Smet Reservoir, in northeast Wyoming, are 340,000 acre-ft and 239,000 acre-ft, respectively.

Legally, CBM product water can be discharged on the surface only at National Pollution Discharge Elimination System (NPDES) permitted points (BLM, 1999). It is expected that much of the water will be discharged from pipelines into existing surface drainages. It is impossible to know with certainty how much CBM produced water will be discharged into surface drainages since, in some areas, water storage systems are being constructed to contain water and because there is the possibility that some of the water will be reinjected. Conversely, the estimated discharge rate for individual wells that was presented above (12 gpm) is variable—discharge rates as high as 60 gpm have been reported (PRB, 2000) and the estimated productive life of a CBM well is 10 to 20 years (BLM, 1999a). Over this time, there is great potential for CBM produced water to cause sedimentation and erosion in affected stream channels and tributaries.

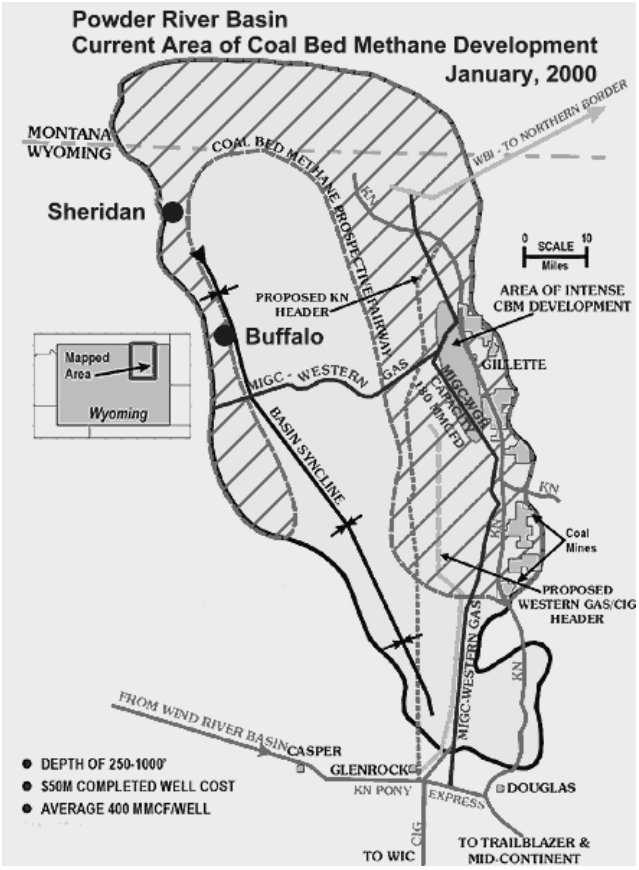

Figure 1 – Powder River Basin. Current area of coal bed methane development (PRB, 2000).

The State of Wyoming, Department of Environmental Quality (DEQ) regulates sedimentation, erosion, and other issues affecting the quality of water in Wyoming (BLM, 1999). The DEQ is also responsible for granting NPDES permits to discharge produced water. Recognizing the need to manage CBM product water, the DEQ has asked the University of Wyoming to evaluate the erosion vulnerability of drainages in the PRB. **The primary objective of this study is to develop a computer program that will help DEQ policy managers formulate appropriate management decisions associated with the NPDES permitting process. This study has three components: (1) development of an analytical model for predicting the erosion potential of a channels in the PRB, (2) channel monitoring, and (3) model verification.** The computer program and all data derived from this effort will be made available to the public so that others responsible for or concerned about watersheds affected by CBM development will be able to use it to evaluate alternative CBM product water management development scenarios.

Methodology:

Model development and implementation

An analysis of data published by the U.S. Geological Survey (Lowham, 1988) is being performed and the results are being used to develop an analytical model that yields an erosion potential index for channels in the PRB.

The analytical model will be implemented in a computer program called Erosion Potential (EP) Modeler, which will execute in ArcView, a geographical information system (GIS). A GIS environment facilitates evaluation of the input variables for the model. Input variables for the model are:

1. The point in the channel at which erosion potential is to be assessed. Identification of the point of interest is facilitated by the use of readily available U.S. Geological Survey (USGS) digital raster graphics.
2. The drainage area for the point in the channel. The computer program computes the drainage area using USGS digital elevation models (DEMs).
3. The two-year peak discharge for the drainage area, if known
4. The geographic factor for the drainage area (accounts for geographic and orographic effects on peak flows; Lowham, 1988). The program uses a digital raster map to compute geographic factors.
5. The anticipated CBM product water discharge for the drainage area

Output from the program includes the pre- and post-CBM development equilibrium channel width and the percent change in the equilibrium channel width. The percent change in the equilibrium width is the erosion potential index. Figure 2 shows a screen capture from an EP Modeler demonstration and illustrates results obtained from the program.

Channel monitoring effort

The second component of this project consists of monitoring erosion in two channels within the Powder River Basin: Deadhorse Creek and Burger Draw. Six reaches along Deadhorse Creek and its tributaries, and two reaches along Burger Draw have been established. A survey of each reach was performed in either March or August 2000 and again in August 2001 using a Sokkia SET 3110 total station. Established reach lengths range from 500 ft to 1,200 ft. Within each reach, four to eight cross-sections were established and surveyed**.** A survey of the channel centerline was also performed. Thus far, the channel monitoring effort has thus far provided baseline data that will be compared with data to be collected in the future.

Model verification and calibration

To achieve the third objective of this study, data from the channel monitoring effort will be used to verify the reasonableness of pre- and post-CBM development equilibrium channel widths predicted using EP Modeler and to calibrate EP Modeler.

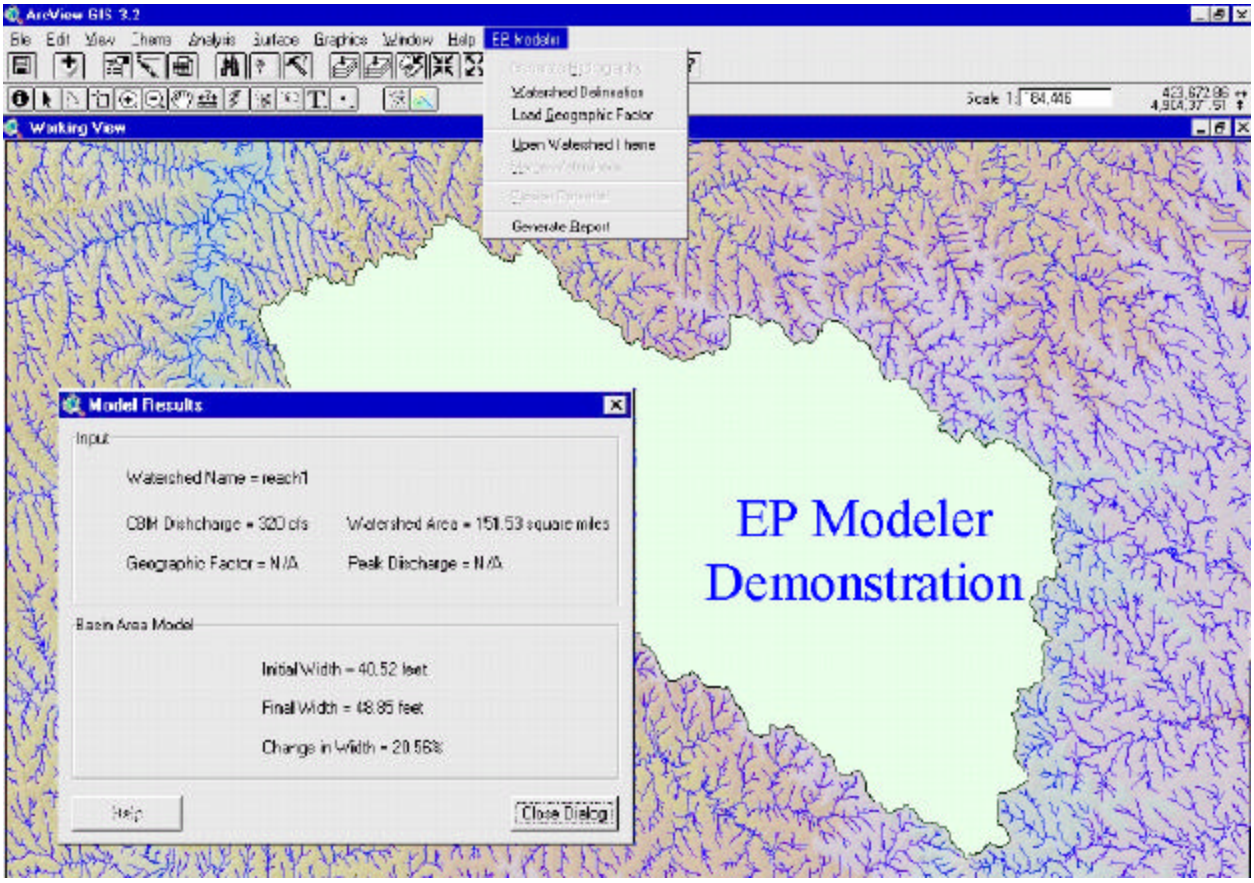

Figure 2 – Screen capture from a demonstration of EP Modeler.

Principal Findings and Significance:

Principal findings to date indicate that the data in Lowham (1988) can be used to estimate equilibrium widths for channels in the PRB. The model developed for predicting equilibrium channel widths has a standard error of 0.55 ft in log units. The computer program being developed for this study, EP Modeler, is in the final stages of completion. The program, a user's manual, and technical report describing the program will be completed by the end of July 2002 and will be made available via the world wide web.

Data from field surveys performed in the year 2000 has been evaluated. Data from the 2001 and 2002 surveys will be processed and documented by the end of February 2003. Validation and calibration of EP Modeler will be performed on an ongoing basis as new survey data is processed.

The model and data derived from this study are significant because it will help DEQ policy managers formulate appropriate management decisions associated with the NPDES permitting process particularly in regards to managing CBM product water. Also, since the computer program and all data derived from this effort will be made available to the public, others

responsible for or concerned about watersheds affected by CBM development will be able to use it to evaluate alternative CBM product water management development scenarios.